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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Diana Xiaobing MA

Attorneys Docket: AM-5825

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Examiner: R. Rocchegiani

For: "INTEGRATED SYSTEM FOR OXIDE ETCHING AND METAL LINER DEPOSITION"

Commissioner for Patents
Alexandria, VA 22313-1450

APPEAL BRIEF UNDER 37 CFR §41.37

Sir:

This Appeal Brief is filed in support of the appeal of the above application dated July 7, 2004.

(1) REAL PARTY IN INTEREST

The real party in interest in this appeal is the assignee, Applied Materials, Inc. of Santa Clara, California.

(2) RELATED APPEALS AND INTERFERENCES

There are no other known appeals or interferences related to this application.

(3) STATUS OF CLAIMS

Claims 12, 13, 18, and 21 have been canceled. Claims 1-11, 14-17, 19, 20, and 22-39 are all pending and are all rejected and appealed

(4) STATUS OF AMENDMENTS

All amendments have been entered.

(5) SUMMARY OF THE CLAIMED SUBJECT MATTER

The invention as more precisely described in the claims includes an integrated etch and metal liner deposition process. The invention of base claim 5 recites a more general process for the etching steps, but the remaining base claims recite a multi-step process generally illustrated in FIG. 9 and described at page 12, line 22 to page 17, line 9, which process may be performed in the integrated platform 700 of FIG. 10. The individual processing steps 48, 50, 54, 58, 60 of FIG. 11 are described in more detail in the background section at page 3, line 22 to page 5, line 4 although the prior-art process is stated at page 5, lines 23-25 to perform the sputtering on a separate platform apart from the etching steps. The ashing may be performed either

In step 40, as described at page 13, lines 9-238 and page 14, line 4 to page 15, line 6, a wafer having a patterned etching mask is transferred into a first transfer chamber 1000 held at a moderate pressure below 1 milliTorr. From the first transfer chamber 1000, the wafer is transferred to an oxide etch chamber 106 for the oxide etch step 44 and to an ash/strip chamber 108 for the photoresist ashing step 46, the barrier stripping step 48, and possibly the cleaning step 50. Alternatively, the ashing may be performed in the oxide etch chamber.

In step 56, as described at page 13, lines 18, 19 and page 15, lines 6-20, the wafer is transferred from the first transfer chamber 1000, through one of two doubly gated passthrough

chambers 1120, 1140, to a second transfer chamber 1200 held at a higher vacuum. From the second transfer chamber, the wafer is transferred to a tantalum sputtering chamber 124 for the metal barrier deposition step 58 and to a copper sputtering chamber 126 for the copper seed deposition step 60.

As clearly stated at page 13, lines 3-8, the first transfer chamber 1000 is held at a higher pressure than the second transfer chamber 1200, the pressure in the second transfer chamber 12– preferably being no more than 10^{-6} Torr versus a typical pressure of 150 milliTorr in the first transfer chamber 1000. An intermediate load lock (a pass through chamber) between the two transfer chambers provide vacuum isolation between them. As described at page 15, lines Each pass through chamber has two selectively openable slit valves between it and the two transfer chambers.

(6) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-11, 14-17, 19, 20, and 22-39 stand rejected under 35 U.S.C. §103(a) as being obvious over:

Applicants' admitted prior art; and
Tepman (U.S. Patent 5,186,718).

(7) ARGUMENT

<u>Claims 1-9, 22-27, 29-34, and 36-39</u>

The Examiner holds that Applicants admit that the processing steps aside the apparatus and the pressure isolation are old. Applicants however contend for claims 1-9, 22-27, 29-34, and 36-39 that Tepman fails to teach a single integrated platform in which etching is performed in a reactor attached to Tepman's higher-pressure first transfer chamber 40 and metallization or other deposition is performed in a reactor attached to Tepman's lower-pressure second transfer chamber 44.

Tepman only generally describes the type of processing to be performed in his integrated

system, saying it may include etching and/or deposition (col. 4, line 7) although it is well known in the trade that Tepman is describing the early Endura system primarily directed to sputtering, which requires a very high vacuum. In any case, Tepman reserves the processing chamber 34 attached to the low-pressure second robot chamber 24 (col. 3, line 62 to col. 4, line 3) for processing of the etching and/or deposition. On the other hand, chamber 44, 46 attached to the high-pressure first robot chamber 24 my be used for orienting, (col. 5, l. 22), pre-processing or post-processing (col. 5, ll, 26-29) or for processing itself (col. 5, l. 30), for example, using different or incompatible chemistries. The most specific example given at col. 5, ll. 39-40 places corrosive gas chemistry in the chambers 34 attached to the low-pressure transfer chamber so as to not affect the processing/treatment in the chambers 44, 46 attached to the high-pressure transfer chamber. This description does not even describe etching through a mask and more importantly does separate the etching and sputtering reactors between the two transfer chamber with the sputter reactors being attached to the low-pressure transfer chamber. In fact, placing corrosive chemistries, e.g. etching, in the low-pressure transfer chamber is the opposite of that being claimed. Tepman simply fails to suggest segregating etching reactors in the high-pressure transfer chamber and sputter reactors in the low-pressure transfer chamber to sputtering.

The claimed etching around the first transfer chamber through a patterned mask material does not constitute Tepman's pre-preprocessing or plasma etch cleaning. Tepman fails to suggest any advantage for performing patterned etching in a reactor attached to the first transfer chamber while performing deposition in a reactor attached to the second transfer chamber. Plasma etch cleaning, typically involving a very light or shallow etch, often with plasmas of only inert gases or possibly oxygen differs significantly from patterned etching of typically much deeper features typically involving halide chemistry and in which a relatively thick mask needs to thereafter be removed. While Tepman's integrated tool can be adapted to the configuration required by the claims, such separation of patterned etching and deposition/sputter is not suggested by Tepman.

The Examiner argues that the claimed invention would be obvious to use in the Tepman

integrated tool since such use "would result in a process with less contamination, increase throughput, with minimal pump down time, and a vacuum system with enhanced capability." This conclusory statement does not address the claimed elements but only describes the benefits of the claimed combination applied in hindsight to Tepman's tool without further justification.

For these reasons, claims 1-9, 22-27, 29-34, and 36-39 should be held allowable.

Claims 10-21, 28, and 35

In addition to the reasons for patentability presented for the previously discussed claims, which apply equally to claims 10-21, 28, and 35, the latter claims also require that an ashing step be performed in a reactor coupled to the first transfer chamber. Tepman fails to suggest that mask ashing should be performed in his integrated tool. In fact, in the past ashing has mostly been performed in a free-standing multi-wafer barrel asher disposed in the atmospheric process path between an etch station and a sputtering station. Such a barrel asher cannot be easily combined with Tepman's integrated tool This conventional barrel ashingcontrasts to the claimed ashing in a reactor coupled to a vacuum transfer chamber. Lacking a teaching for performing an ashing step in Tepman's two-stage integrated tool, these claims should be held additionally allowable.

(9) CONCLUSION

Accordingly, claims 1-39 should be held allowable for the reasons presented for claims 1-9, 22-27, 29-34, and 36-39. Claims 10-21, 28, and 35 should be held additionally allowable. The Board is respectfully requested to instruct the Examiner to allow these claims.

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APPENDIX

Claims on Appeal

1. An integrated etch and metal liner process of a substrate including a dielectric layer and covered with a patterned mask material, comprising the steps of:

a first step of transferring the substrate into a first transfer chamber held at a first pressure below atmospheric pressure;

a second step of transferring the substrate from the first transfer chamber to an etching chamber and etching according to said patterned mask material through said dielectric layer to an etch stop layer to form a hole in said dielectric layer;

ashing said mask material;

removing said etch stop layer exposed at a bottom of said hole;

a third step of transferring the substrate from the first transfer chamber to a second transfer chamber through an intermediate load lock, wherein said first transfer chamber is vacuum isolated from said second transfer chamber throughout said third transferring step;

a fourth step of transferring said substrate from said second transfer chamber to a metallization chamber without exposing the substrate to an atmospheric pressure;

depositing a barrier layer in said metallization chamber; and

depositing a seed layer.

2. The process of Claim 1, wherein said metal seed layer is a copper seed layer.

3. The process of Claim 2, wherein said barrier layer comprises tantalum.

4. The process of Claim 1, wherein at least one of said two depositing steps is a sputtering step.

5. An integrated etch and metal liner process of a substrate including an etch stop layer covered with a dielectric layer covered with a patterned mask material, comprising the steps of:

etching according to said mask through said dielectric layer to said etch stop layer to form a hole in said dielectric layer;

ashing said mask material;

removing said etch stop layer exposed at a bottom of said hole;

a first step of transferring said substrate to a first transfer chamber maintained at a sub-atmospheric pressure;

a second step of transferring said substrate from said first transfer chamber to a second transfer chamber through an intermediate load lock, wherein said second transfer chamber is isolated from said first transfer chamber throughout said second transferring step;

in a reactor coupled to said second transfer chamber, depositing a barrier layer; and

in a reactor coupled to said second transfer chamber, depositing a metal seed layer;

wherein said substrate is maintained between said etching, ashing and removing steps and throughout said transferring steps at sub-atmospheric pressures.

6. The process of Claim 5, wherein said barrier layer comprises tantalum.

7. The process of Claim 5, wherein at least one of said depositing steps is a sputtering step.

8. The process of Claim 5, wherein said second transfer chamber is maintained at a pressure of less than 10^{-6} Torr.

9. An integrated etch and metal liner process of a substrate including a stop layer covered with an oxide layer covered with a patterned photoresist mask, comprising the steps of:

a first step of transferring said substrate into a first transfer chamber maintained at a first

pressure of no more than 1 Torr;

a second step of transferring said substrate from said first transfer chamber to an oxide etch reactor;

in said oxide etch reactor, etching said oxide layer according to said mask to form a hole in said oxide layer;

a third step of transferring said substrate from said oxide etch reactor through said first transfer chamber to a second transfer chamber isolated from and first transfer chamber throughout said third transferring step and maintained at a second pressure less than said first pressure; and

a fourth step of transferring said substrate from said second transfer chamber to at least one reactor to deposit a layer in said hole.

10. The process of Claim 9, further comprising ashing said photoresist layer in said oxide etch reactor.

11. The process of Claim 9, further comprising:

a fifth step of transferring said substrate from said oxide etch reactor through said first transfer chamber to a plasma ashing reactor attached to said first transfer chamber; and

in said plasma ashing reactor, ashing said photoresist layer;

wherein said third step of transferring comprises transferring said substrate from said plasma ashing reactor through said first transfer chamber to said second transfer chamber.

14. (Previously presented) An integrated process performed in processing reactors connected to first and second central vacuum transfer chambers held at pressures of no more than 1 Torr, said first and second central vacuum transfer chambers being linked by a doubly gated vacuum passageway, said processing reactors, said first and second central vacuum transfer chambers, and said vacuum passageway being formed on a single platform, said process

comprising the steps of:

loading into said first central vacuum transfer chamber through a load lock a substrate having a dielectric layer covered by a patterned resist material;

in at least one etching reactor connected to said first central vacuum transfer chamber through a respective slit valve, etching said dielectric layer in said substrate according to said patterned resist material to form a hole therethrough and thereafter ashing said resist material;

transferring said substrate through said doubly gated vacuum passageway from said first central vacuum transfer chamber to said second central vacuum transfer chamber while continuing to vacuum isolate said first and second central transfer chambers from each other;

in at least one deposition reactor connected to said second central vacuum transfer chamber through a respective slit valve, depositing a liner layer on sides of said hole;

wherein said substrate is not exposed to atmospheric pressure between said etching step and said depositing step.

15. The process of Claim 14, wherein said liner layer includes a barrier layer and a copper seed layer.

16. The process of Claim 14, wherein said at least one deposition reactor includes a sputter reactor with a copper target for depositing said copper seed layer.

17. The process of Claim 14, wherein said at least one etching reactor includes an etch reactor for etching said dielectric layer and an ashing reactor for ashing said resist material.

19. The process of Claim 14, wherein said at least one etching reactor includes an etch reactor for etching said dielectric layer and an ashing reactor for ashing said resist material and wherein said at least one deposition reactor includes a first sputter reactor for depositing at least a part of a barrier layer and a second sputter reactor for depositing a copper seed layer.

20. The process of Claim 14, wherein said second central vacuum transfer chamber is held at a pressure of no more than 10^{-6} Torr.

22. The process of Claim 1, wherein said etching is performed using a fluorine-based chemistry.

23. The process of Claim 1, wherein said intermediate load lock is doubly gated and includes a pedestal for supporting said substrate which is accessible by two substrate-handling robots located respectively in said first and transfer chambers, whereby said first and second transfer chambers are vacuum isolated from each other during transfer of said substrate through said intermediate load lock during said third transferring step.

24. The process of Claim 5, wherein said etching step uses a fluorine-containing etching gas.

25. The process of Claim 5, wherein said intermediate load lock is doubly gated and includes a pedestal for supporting said substrate which is accessible by two substrate-handling robots located respectively in said first and second transfer chambers, whereby said first and second transfer chambers are vacuum isolated from each other during transfer of said substrate through said intermediate load lock during said second transferring step.

26. The process of Claim 9, wherein said etching step uses a fluorine-containing etching gas.

27. The process of Claim 9, wherein said first and second transfer chambers are isolated by a doubly gated load lock through which said substrate is transferred in said third transferring step.

28. The process of Claim 14, wherein said etching step uses a fluorine-containing etching gas.

29. The process of Claim 23, further comprising throughout said third transferring step:

maintaining said first transfer chamber at a first pressure; and

maintaining said second transfer chamber at a second pressure lower than said first pressure.

30. The process of Claim 25, further comprising throughout said transferring step:

maintaining said first transfer chamber at a first pressure; and

maintaining said second transfer chamber at a second pressure lower than said first pressure.

31. The process of Claim 27, further comprising throughout said third transferring step:

maintaining said first transfer chamber at a first pressure; and

maintaining said second transfer chamber at a second pressure lower than said first pressure.

32. The process of Claim 1, wherein said steps are sequentially performed in the stated order.

33. The process of Claim 5, wherein said steps are sequentially performed in the stated order.

34. The process of Claim 9, wherein said steps are sequentially performed in the stated order.

35. The process of Claim 14, wherein said steps are sequentially performed in the stated order.

36. An integrated etch and deposition process of a substrate including a dielectric layer and covered with a patterned mask material, comprising the sequentially performed steps of:

a first step of transferring the substrate into a first transfer chamber held at a first pressure below atmospheric pressure;

a second step of transferring the substrate from the first transfer chamber to an etching chamber attached to said first transfer chamber and etching said dielectric layer according to said patterned mask material to form a hole in said dielectric layer;

a third step of transferring the substrate from the first transfer chamber to a second transfer chamber through an intermediate load lock, wherein said first transfer chamber is vacuum isolated from said second transfer chamber throughout said third transferring step;

a fourth step of transferring said substrate from said second transfer chamber to a first metallization chamber coupled to said second transfer chamber through a first slit valve without exposing the substrate to an atmospheric pressure;

depositing a first metal layer on said substrate in said first metallization chamber.

37. The process of Claim 36, further comprising the subsequent steps of:

a fifth step of transferring said substrate from said first metallization chamber to a second metallization chamber coupled to said second transfer chamber through a second slit valve without exposing the substrate to an atmospheric pressure; and

depositing a second metal layer on said substrate in said second metallization chamber.

38. The process of Claim 37, wherein said first metal layer is a barrier layer and said second metal layer is a copper seed layer deposited by physical vapor deposition.

39. The process of Claim 36, further including ashing said mask material in a reactor connected to said first transfer chamber prior to said substrate being transferred into said second transfer chamber.